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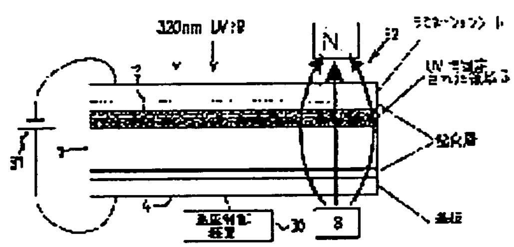
## (54) FILTER AND PRODUCTION OF OPTICAL DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To obtain a process for producing an optical device with a single film by including specific stages, thereby controlling the threedimensional structure of the polymer film.
SOLUTION: A polymerizable or crosslinkable cholesteric liquid crystal material is used and this cholesteric liquid crystal material is controlled to the desired three-dimensional structure and is polymerized or crosslinked in this state by impressing an external field (for example, electric field), by which this structure is fixed. If, for example, the thickness of the film 1 is about 10 microns, the first physical condition of the film 1 as established by establishing the prescribed time and prescribed temp. by a temp.



controller 30 and using adequate means, such as impressing of the electric field on the film by a battery 31 or impressing a magnetic field thereon by a magnet 32. The front surface 2 of the film 1 is thereafter irradiated with UV rays having a wavelength of 320 nanometer so that the UV rays are substantially completely absorbed in the layer of 3 microns depth from the front surface 2. The characteristics of the irradiated region 3 are substantially fixed by the subsequent irradiation.

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CLAIMS

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[Claim(s)]
[Claim 1] The process which is the manufacture approach of single film optical equipment, and forms the layer of the cholesteric-liquid-crystal ingredient which can construct [ that the (a) polymerization is possible or ] a bridge, (b) by irradiating by the process which establishes the 1st physical condition of this layer, and radiation of (c) this layer which penetrates this layer for the 1st field at least from the 1st front face of this layer to the 1st depth smaller than the thickness of this layer the process which starts the 1st polymerization or bridge formation, and (d) -- this -- the process which establishes the 2nd different physical condition of this layer from the 1st physical condition, and (e) -- by irradiating this 1st field at least by radiation which penetrates the whole thickness of this layer How to include the process which starts the 2nd polymerization or bridge formation.
[Claim 2] (f) The approach according to claim 1 of including further said process (a) and the process which carries out orientation processing of said layer between (b).
[Claim 3] The approach according to claim 2 said process (f) includes the process which maintains said layer at the 1st predetermined time amount and the 1st predetermined temperature.
[Claim 4] An approach given in either of claims 1-3 in which said process (a) includes the process which forms said layer on a substrate.
[Claim 5] The method according to claim 2 or 3 of said process (a) including the process which forms said layer on a substrate, and having the orientation front face where this substrate carries out orientation processing of this layer.
[Claim 6] An approach given in either of claims 1-5 said whose radiation is electromagnetic radiation.
[Claim 7] The approach according to claim 6 said electromagnetic radiation is ultraviolet rays.
[Claim 8] The approach according to claim 7 radiation of said process (c) has wavelength shorter than radiation of said process (e).
[Claim 9] (g) An approach given in either of claims 1-8 which includes further the process which starts the further polymerization or bridge formation the process which establishes the further physical conditions of said different layer from said 1st and 2nd physical conditions, and by irradiating by radiation which penetrates this layer from the (h) this 1st front face to the further larger and depth smaller than the thickness of this layer than said 1st depth.
[Claim 10] (g) To the further larger and depth smaller than the thickness of this layer than said 1st depth from the process which establishes the further physical conditions of said different layer from said 1st and 2nd physical conditions, and the (h) this 1st front face The approach according to claim 7 or 8 include further the process which starts the further polymerization or bridge formation by irradiating by radiation which penetrates this layer, and radiation of this process (h) has long wave length rather than radiation of said process (e).
[Claim 11] (g) To the further larger and depth smaller than the thickness of this layer than said 1st depth from the process which establishes the further physical conditions of said different layer from said 1st and 2nd physical conditions, and the (h) this 1st front face The approach according to claim 7 or 8 include further the process which starts the further polymerization or bridge formation by irradiating by radiation which penetrates this layer, and radiation of this process (h) has main bigger wavelength than radiation of said process (c).

[Claim 12] The approach according to claim 10 radiation of said process (h) has main bigger wavelength than radiation of said process (c).
[Claim 13] An approach given in either of claims 9-12 whose exposure of said process (h) is an exposure of said 1st field.
[Claim 14] An approach given in either of claims 9-12 whose exposure of said process (h) is an exposure of said 1st field and the 2nd different field.
[Claim 15] An approach given in either of claims 1-14 in which either [ at least ] (b) of said process or (d) includes the process which impresses electric field or a field to said layer.
[Claim 16] An approach given in either of claims 1-15 in which either [ at least ] (b) of said process or (d) includes the process which maintains said layer at each predetermined time amount and each predetermined temperature.
[Claim 17] An approach given in either of claims 1-14 which includes the process to which said process (d) enables diffusion to happen in the 2nd predetermined time amount and said layer.
[Claim 18] An approach given in either of claims 1-17 in which said 1st field includes two or more 1st picture element fields.
[Claim 19] The approach according to claim 14 said 1st field includes two or more 1st picture element fields, and said 2nd field includes two or more 2nd picture element fields.
[Claim 20] An approach given in either of claims 1-19 in which said optical equipment includes a part optical filter.
[Claim 21] An approach given in either of claims 1-20 which includes further the process which is said 1st front face or forms a wavelength plate in said layer on the 2nd front face.
[Claim 22] The approach according to claim 21 said wavelength plate is a quarter wavelength plate.
[Claim 23] The approach according to claim 21 or 22 that said wavelength plate is prolonged over said 1st or 2nd whole front face.
[Claim 24] Penetrate the optical radiation of the 1st circular polarization of light of the 1st wavelength range which carries out incidence to an input front face. Are the filter which includes two or more layers, and the 1st layer of two or more of these layers carries out incidence to a right angle. Reflect radiation of this 1st circular polarization of light of the 2nd wavelength range lower than this 1st wavelength range. The 1st cholesteric reflector is included. The 2nd layer of two or more of these layers Reflect radiation of this 1st circular polarization of light of the 3rd wavelength range below this 2nd wavelength range that was penetrated by this 1st reflector and that carries out incidence to a right angle. The 2nd cholesteric reflector is included. The 3rd layer of two or more of these layers Carry out incidence to the right angle penetrated by these 1st and 2nd reflectors. The 4th wavelength range which is between these 1st and 2nd wavelength ranges partially at least, Reflect radiation of this 1st circular polarization of light and the 2nd circular polarization of light which intersects perpendicularly substantially. The 3rd cholesteric reflector is included. The layer between this input front face and this 3rd reflector The filter with which the non-right-angle incident radiation of this 2nd wavelength range has at least a total rate of a birefringence to the non-right-angle incident radiation of this 2nd wavelength range that is changed into this 2nd circular polarization of light from this 1st circular polarization of light partially.
[Claim 25] The filter according to claim 24 with which said 4th wavelength range includes the yellow-orange part of a visible spectrum.
[Claim 26] Penetrate the optical radiation of the 1st circular polarization of light of the 2nd wavelength range which carries out incidence to an input front face. Are the filter which includes two or more layers, and the 1st layer of two or more of these layers carries out incidence to a right angle. The 1st cholesteric reflector which reflects radiation of this 1st circular polarization of light of the 5th wavelength range is included. The 2nd layer of two or more of these layers was penetrated by this 1st reflector. Reflect radiation of this 1st circular polarization of light of the 3rd wavelength range below this 2nd wavelength range that carries out incidence to a right angle. The 2nd cholesteric reflector is included. The 3rd layer of two or more of these layers Carry out incidence to the right angle penetrated by these 1st and 2nd reflectors. Reflect radiation of this 1st circular polarization of light of the 1st wavelength range between these 5th and 2nd wavelength ranges. The 3rd cholesteric reflector is included. The 4th layer of two or more of these layers Carry out incidence to the right angle penetrated by these 1st, 2nd, and 3rd reflectors. Reflect radiation of this 1st circular polarization of light of this 2nd wavelength range, and the 2nd circular polarization of light which

intersects perpendicularly substantially. The 4th cholesteric reflector is included. The layer between this input front face and this 3rd reflector As [ change / at least / the non-right-angle incident radiation of this 2nd wavelength range / from this 1st circular polarization of light / into this 2nd circular polarization of light / partially ] It has a total rate of a birefringence to the non-right-angle incident radiation of this 2nd wavelength range. The layer between this input front face and this 4th reflector The filter with which the non-right-angle incident radiation of this 3rd wavelength range has at least a total rate of a birefringence to the non-right-angle incident radiation of this 3rd wavelength range that is changed into this 2nd circular polarization of light from this 1st circular polarization of light partially.

[Claim 27] Penetrate the optical radiation of the 1st circular polarization of light of the 3rd wavelength range which carries out incidence to an input front face. Are the filter which includes two or more layers, and the 1st layer of two or more of these layers carries out incidence to a right angle. Reflect radiation of this 1st circular polarization of light of the 5th wavelength range above this 3rd wavelength range. The 1st cholesteric reflector is included. The 2nd layer of two or more of these layers The 1st wavelength range between these 5th and 3rd wavelength ranges that were penetrated by this 1st reflector and that carry out incidence to a right angle, The 2nd cholesteric reflector which reflects radiation of this 1st circular polarization of light is included. The 3rd layer of two or more of these layers was penetrated by these 1st and 2nd reflectors. The 2nd wavelength range between these 1st and 3rd wavelength ranges that carry out incidence to a right angle, The 3rd cholesteric reflector which reflects radiation of this 1st circular polarization of light is included. The filter with which the non-right-angle incident radiation of this 3rd wavelength range has a total rate of a birefringence to the non-right-angle incident radiation of this 3rd wavelength range that is changed into this 1st circular polarization of light and the 2nd circular polarization of light which intersects perpendicularly substantially partially [ the layer between this input front face and this 3rd reflector ] at least.

[Claim 28] The filter according to claim 26 or 27 said whose 5th wavelength range is a part for infrared [ of a spectrum ].

[Claim 29] For said 1st, 2nd, and 3rd wavelength ranges, a visible spectrum is each a filter given in either of claims 24-28 which includes red, green, and a blue part.

[Claim 30] A filter given in either of claims 24-28 which was manufactured by the approach according to claim 1.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of optical equipment. This invention relates to the filter which may be used as for example, a part optical filter again. Such optical equipment and a filter may be used by liquid crystal, a display, an interference filter, a color filter, holography, optics, electronic measurement, and the detection system, and fit the application of the Takamitsu bundle.
[0002]
[Description of the Prior Art] R. Maurer et al., "Polarising Colour Filters made from Cholesteric LC Silicones", SID digest, and 110-112 The page (1990) is indicating use of the cholesteric-liquid-crystal polymer for a color filter. Such a filter reflects the circular polarization of light with the limited bandwidth, and penetrates the opposite circular polarization of light. If the laminating of the cholesteric color filter is carried out, it will become possible to obtain the component which penetrates only the wavelength of the narrow-band of a visible spectrum. This technique may be used in order to produce the red and green suitable for use on a display, and the transparency mold primary color color filter for blue. a cholesteric film -- for example, United States patent 4th -- patterning may be carried out with lithography by exposing the field of a film to an ultraviolet (UV) exposure at different temperature so that it may be indicated by 637 896 No.
[0003] EP 606 940 The technique which produces a circular polarization of light child is indicated by extending the reflective bandwidth of a cholesteric film from about 50 nanometers to about 300 nanometers. Especially, the combination of diffusion and UV profile on the strength is used in order to extend the bandwidth of a polarizer. EP 720 041 The back light for liquid crystal equipments (LCD) using the cholesteric transparency mold color filter by which patterning was carried out is indicated. Recycling of the light reflected by the filter is carried out, it is returned to a display, and raises the effectiveness of lighting. For such a color filter to function correctly because of a wide range angle of incidence, for example, to raise the angle of visibility of a display is desired. D.J. Broer and "Molecular Architectures in Thin Plastic Films byIn-Situ Photopolymerisation of Reactive Liquid Crystals", SID 95 digest, and 165-168 Page (1995), G. M.Davis and "Liquid Crystal Polymer Thin Film Anisotropic Optical Components", Sharp Technical Journal, and 22-25 A page, vol.63 (Dec.1995), and United States patent 4th 983 479 No. is indicating the technique of offering three-dimensions control of the order of the molecule of the polymer film using the polymerization or bridge formation by which optical initiation for example, of the liquid crystal molecule was carried out.
[0004] It is common knowledge that the wavelength reflected by the cholesteric film of one pitch changes with an incident angle according to the following formulas.
[0005] lambda(alpha) =lambda0 -- cos [sin-1 (2sin alpha/n)] -- the main wavelength of the light which lambda 0 carries out here and carries out incidence of the main wavelength of right-angle incidence, and lambda (alpha) on square alpha, and n/2 -- an average refractive index (n0+ne) / 2 it is -- n0 and ne are the Tsunemitsu refractive indexes and extraordinary indices of a cholesteric ingredient, respectively. The polarization condition of the reflected light and the penetrated light For example, V.A.Belyakov et al., "Optics of Cholesteric Liquid Crystals", Sov.Phys.Usp.22(2), 63-88 pages (Feb.1979), and G.Joly et al., "OpticalProperties of the Interface between So that it may be

indicated by a Twisted Liquid Crystal and an Isotropic Transparent Medium", J.Optics, vol.25, and 177-186 pages (1994) It is well-known that it is also intricately dependent on the wavelength and the incident angle of the illumination light. Such change and a dependency are not desirable for many applications (for example, color filter) for which it asks for the actuation for which it does not depend on an incident angle substantially. With the gray dead pitch cholesteric equipment which a cholesteric pitch changes and extends reflective bandwidth, angular dependence is more complicated. L.E. Hajdo et al., J.Opt.Soc.Am.vol.69, and No.7 (July 1979)"Theory of Light Reflection by CholestericLiquid Crystals Possessing a Pitch Gradient" are treating only the light which carries out incidence to a cholesteric layer at a right angle.

[0006] GB-A-2 166 755 The approach of carrying out the polymerization of the cholesteric-liquid-crystal monomer alternatively is indicated by carrying out hardening processing of the field as for which carries out the mask of the liquid crystal and a mask is not carried out by ultraviolet radiation exposure. The whole liquid crystal is irradiated. However, since the polymerization of the liquid crystal near the front face of the irradiated field is not completely carried out in order that oxygen may prevent a polymerization, the three-dimensions effectiveness produces it. Therefore, when an exposure is performed in air, the field of the liquid crystal near a front face has a different property from the polymer of the contrant region of liquid crystal. This reference is not indicating the exposure of the liquid crystal in the approach by which the depth by which liquid crystal is irradiated may be controlled.

[0007] GB-A-2 132 623 Manufacture of the structure of having the property of 2-dimensional change is indicated. This property changes on the surface field of structure. A liquid crystal layer is irradiated through the 1st mask under the set of the 1st condition. A mask is removed after that and it irradiates under the conditions from which the field by which a polymerization subsequently is not carried out differs. Although a property changes on the field of structure with these, fixed structure is acquired in the depth of structure.

[0008] EP-A-0 154 953 The light filter which has two separate polymer films is offered. The polymerization of the 1st film is carried out under 1 set of conditions, and the polymerization of the 2nd film is carried out under different conditions.

[0009] EP-A-0 397 263 are indicating the approach of manufacturing a polarizer, by irradiating a liquid crystal monomer.

[0010] a multilayer cholesteric filter -- EP-A-0 720 041 and United States patent 5th -- 548 422 No. and United States patent 4th -- 726 663 and JP,61-032,A a No. 801 official report -- and -- " -- it is indicated by IBM Technical Disclosure Bulletin"Vol 15, No 8, and 2538-2539 pages. In the case of right-angle incidence, these reference is related in the first place.

[0011]

[Problem(s) to be Solved by the Invention] This invention controls the three-dimensional structure of a polymer film, and aims at offering the approach of manufacturing optical equipment with a single film.

[0012]

[Means for Solving the Problem] The manufacture approach of the single film optical equipment of this invention (a) The process which forms the layer of the cholesteric-liquid-crystal ingredient which can construct [ that a polymerization is possible or ] a bridge, (b) by irradiating by the process which establishes the 1st physical condition of this layer, and radiation of (c) this layer which penetrates this layer for the 1st field at least from the 1st front face of this layer to the 1st depth smaller than the thickness of this layer the process which starts the 1st polymerization or bridge formation, and (d) -- this -- the process which establishes the 2nd different physical condition of this layer from the 1st physical condition, and (e) -- by irradiating this 1st field at least by radiation which penetrates the whole thickness of this layer The process which starts the 2nd polymerization or bridge formation is included, and, thereby, the above-mentioned purpose is attained.

[0013] The above-mentioned manufacture approach may include further the (f) aforementioned process (a) and the process which carries out orientation processing of said layer between (b).

[0014] The above-mentioned manufacture approach may include the process at which said process (f) maintains said layer at the 1st predetermined time amount and the 1st predetermined temperature.

[0015] The above-mentioned manufacture approach may include the process at which said process

(a) forms said layer on a substrate.
[0016] Said process (a) may include the process which forms said layer on a substrate, and the above-mentioned manufacture approach may have the orientation front face where this substrate carries out orientation processing of this layer.
[0017] Said radiation of the above-mentioned manufacture approach may be electromagnetic radiation.
[0018] Said electromagnetic radiation of the above-mentioned manufacture approach may be ultraviolet rays.
[0019] The above-mentioned manufacture approach may have wavelength with radiation of said process (c) shorter than radiation of said process (e).
[0020] The above-mentioned manufacture approach may include further the process which starts the further polymerization or bridge formation the process which establishes the further physical conditions of said different layer from the (g) above 1st and the 2nd physical condition, and by irradiating by radiation which penetrates this layer from the (h) this first front face to the further larger and depth smaller than the thickness of this layer than said 1st depth.
[0021] The above-mentioned manufacture approach to the further depth smaller than the thickness of this layer more greatly than the (h) this first front face to the process which establishes the further physical conditions of said different layer from the (g) above 1st and the 2nd physical condition, and said 1st depth By irradiating by radiation which penetrates this layer, the process which starts the further polymerization or bridge formation may be included further, and radiation of this process (h) may have long wave length rather than radiation of said process (e).
[0022] The above-mentioned manufacture approach to the further depth smaller than the thickness of this layer more greatly than the (h) this first front face to the process which establishes the further physical conditions of said different layer from the (g) above 1st and the 2nd physical condition, and said 1st depth By irradiating by radiation which penetrates this layer, the process which starts the further polymerization or bridge formation may be included further, and radiation of this process (h) may have main bigger wavelength than radiation of said process (c).
[0023] The above-mentioned manufacture approach may have main wavelength with bigger radiation of said process (h) than radiation of said process (c).
[0024] The exposure of said process (h) of the above-mentioned manufacture approach may be an exposure of said 1st field.
[0025] The above-mentioned manufacture approach may be the exposure of the 2nd field where the exposure of said process (h) differs from said 1st field.
[0026] The above-mentioned manufacture approach may include the process to which either [ at least ] (b) of said process or (d) impresses electric field or a field to said layer.
[0027] The above-mentioned manufacture approach may include the process at which either [ at least ] (b) of said process or (d) maintains said layer at each predetermined time amount and each predetermined temperature.
[0028] The above-mentioned manufacture approach may include the process to which said process (d) enables diffusion to happen in the 2nd predetermined time amount and said layer.
[0029] As for the above-mentioned manufacture approach, said 1st field may include two or more 1st picture element fields.
[0030] Said 1st field may include two or more 1st picture element fields, and, as for the above-mentioned manufacture approach, said 2nd field may include two or more 2nd picture element fields.

[0031] As for the above-mentioned manufacture approach, said optical equipment may include a part optical filter.
[0032] The above-mentioned manufacture approach may include further the process which is said 1st front face, or is the 2nd front face, and forms a wavelength plate in said layer.
[0033] Said wavelength plate of the above-mentioned manufacture approach may be a quarter wavelength plate.
[0034] As for the above-mentioned manufacture approach, said wavelength plate may be prolonged over said 1st or 2nd whole front face.
[0035] The filter of this invention penetrates the optical radiation of the 1st circular polarization of

light of the 1st wavelength range which carries out incidence to an input front face. Are the filter which includes two or more layers, and the 1st layer of two or more of these layers carries out incidence to a right angle. Reflect radiation of this 1st circular polarization of light of the 2nd wavelength range lower than this 1st wavelength range. The 1st cholesteric reflector is included. The 2nd layer of two or more of these layers Reflect radiation of this 1st circular polarization of light of the 3rd wavelength range below this 2nd wavelength range that was penetrated by this 1st reflector and that carries out incidence to a right angle. The 2nd cholesteric reflector is included. The 3rd layer of two or more of these layers Carry out incidence to the right angle penetrated by these 1st and 2nd reflectors. The 4th wavelength range which is between these 1st and 2nd wavelength ranges partially at least, Reflect radiation of this 1st circular polarization of light and the 2nd circular polarization of light which intersects perpendicularly substantially. The 3rd cholesteric reflector is included. The layer between this input front face and this 3rd reflector The non-right-angle incident radiation of this 2nd wavelength range has at least a total rate of a birefringence to the non-right-angle incident radiation of this 2nd wavelength range that is partially changed into this 2nd circular polarization of light from this 1st circular polarization of light, and, thereby, the above-mentioned purpose is attained.

[0036] Said 4th wavelength range may include the yellow-orange part of a visible spectrum.

[0037] The above-mentioned filter penetrates the optical radiation of the 1st circular polarization of light of the 2nd wavelength range which carries out incidence to an input front face. Are the filter which includes two or more layers, and the 1st layer of two or more of these layers carries out incidence to a right angle. The 1st cholesteric reflector which reflects radiation of this 1st circular polarization of light of the 5th wavelength range is included. The 2nd layer of two or more of these layers was penetrated by this 1st reflector. Reflect radiation of this 1st circular polarization of light of the 3rd wavelength range below this 2nd wavelength range that carries out incidence to a right angle. The 2nd cholesteric reflector is included. The 3rd layer of two or more of these layers Carry out incidence to the right angle penetrated by these 1st and 2nd reflectors. Reflect radiation of this 1st circular polarization of light of the 1st wavelength range between these 5th and 2nd wavelength ranges. The 3rd cholesteric reflector is included. The 4th layer of two or more of these layers Carry out incidence to the right angle penetrated by these 1st, 2nd, and 3rd reflectors. Reflect radiation of this 1st circular polarization of light of this 2nd wavelength range, and the 2nd circular polarization of light which intersects perpendicularly substantially. The 4th cholesteric reflector is included. The layer between this input front face and this 3rd reflector As [ change / at least / the non-right-angle incident radiation of this 2nd wavelength range / from this 1st circular polarization of light / into this 2nd circular polarization of light / partially ] It has a total rate of a birefringence to the non-right-angle incident radiation of this 2nd wavelength range. The layer between this input front face and this 4th reflector The non-right-angle incident radiation of this 3rd wavelength range has at least a total rate of a birefringence to the non-right-angle incident radiation of this 3rd wavelength range that is partially changed into this 2nd circular polarization of light from this 1st circular polarization of light, and, thereby, the above-mentioned purpose is attained.

[0038] The filter of this invention penetrates the optical radiation of the 1st circular polarization of light of the 3rd wavelength range which carries out incidence to an input front face. Are the filter which includes two or more layers, and the 1st layer of two or more of these layers carries out incidence to a right angle. Reflect radiation of this 1st circular polarization of light of the 5th wavelength range above this 3rd wavelength range. The 1st cholesteric reflector is included. The 2nd layer of two or more of these layers The 1st wavelength range between these 5th and 3rd wavelength ranges that were penetrated by this 1st reflector and that carry out incidence to a right angle, The 2nd cholesteric reflector which reflects radiation of this 1st circular polarization of light is included. The 3rd layer of two or more of these layers was penetrated by these 1st and 2nd reflectors. The 2nd wavelength range between these 1st and 3rd wavelength ranges that carry out incidence to a right angle, The 3rd cholesteric reflector which reflects radiation of this 1st circular polarization of light is included. The layer between this input front face and this 3rd reflector the non-right-angle incident radiation of this 3rd wavelength range At least, partially, it has a total rate of a birefringence to the non-right-angle incident radiation of this 3rd wavelength range that is changed into this 1st circular polarization of light and the 2nd circular polarization of light which intersects perpendicularly

substantially, and, thereby, the above-mentioned purpose is attained.
[0039] Said 5th wavelength range may be a part for infrared [ of a spectrum ].
[0040] said 1st, 2nd, and 3rd wavelength ranges -- each of a visible spectrum -- red, green, and a blue part may be included.
[0041] An operation of this invention is explained below.
[0042] Since the manufacture approach by this invention produces a polymer film using the cholesteric-liquid-crystal ingredient which can construct [ that a polymerization is possible or ] a bridge, it can make it take the desired three-dimensional structure by impressing the suitable outside place (for example, electric field) for a cholesteric-liquid-crystal ingredient. Where a cholesteric-liquid-crystal ingredient is controlled to the desired three-dimensional structure, the structure is fixable a polymerization or by making a bridge construct. The film with which this three-dimensional structure was fixed is single, and functions as optical equipment.
[0043]
[Embodiment of the Invention] An example explains this invention in more detail, referring to an attached drawing.
[0044] It lets the whole drawing pass and the same reference mark is given to the same part.
[0045] Drawing 1 a - 1c shows how to produce single film optical equipment. This approach may be used in order that a reflection property, a transparency property, and an include-angle property may produce the optical equipment controlled to state below. Three-dimensions perpendicular accumulation structure is formed in the film of a cholesteric ingredient fixable by UV. The film shown in drawing 1 a - 1c is about 10 microns in thickness.
[0046] This approach is enforced at some processes and drawing 1 a - 1c shows the approach of three processes. At the 1st process shown in drawing 1 a, the 1st predetermined physical condition of a film 1 is established. Physical conditions may be established by suitable means of arbitration of impressing electric field to a film by 31, or impressing a field by 32, as shown in drawing etc. to establish predetermined time amount and predetermined temperature with a temperature controller 30. The upper front face 2 of a film 1 is irradiated by UV line which has the wavelength of 320 nanometers after that, and from a front face 2, this is a layer with a depth of 3 microns and is absorbed completely substantially. The property of the irradiated field 3 is substantially fixed by the postoperativus irradiation.
[0047] At the 2nd process shown in drawing 1 b, the technique which described the 1st process, for example is used for arbitration, or the further predetermined time amount and the existing impression conditions are only continued, and new physical properties are established in a non-fixed area. A film 1 is irradiated after that by UV line which has the wavelength of 330 nanometers, and this has absorption depth equal to 5 microns substantially. The field where the property was fixed is extended as shown by 3' after that.
[0048] At the 3rd process shown in drawing 1 c, the further physical condition of a film 1 is established and a film 1 is irradiated on a front face 2 by UV line with a wavelength of 340 nanometers. The wavelength of this UV line is substantially absorbed in a depth of 9 microns, and forms fixed field 3." Field 3" is equivalent to the thickness of the cholesteric-liquid-crystal polymer film 1.
[0049] The wavelength and the wavelength range of UV line which are used at the process of this approach are chosen, and the depth of the absorption from a front face 2 into a film 1 is controlled. The process of the number of arbitration may be applied so that the layer of the optical property from which the number of arbitration differs may be formed in a film 1 in principle. If required, a final process may include the process which irradiates a film 1 by the broadband UV line so that the film 1 whole may certainly be fixed covering the whole depth. Furthermore, the field where films 1 differ may be processed by different approach so that the optical equipment with which properties differ by three dimensions may be offered with suitable masking. Therefore, the equipment which has the group of the picture element of a different optical property and by which picture element division was carried out can be offered.
[0050] The physical condition of a film 1 may be changed by changing the temperature between UV irradiation as mentioned above. Drawing 2 shows the change fixable by UV to the temperature of the wavelength of reflection of a typical cholesteric-liquid-crystal polymer. By enabling physical

condition of a film 1 to change temperature between processes and to stabilize at new temperature, combine in order to offer the structure suitable for the reflective field of a color which is different on a film 1 being formed, for example, penetrating red light, green light, and blue glow.
[0051] In the distance, un-fixing or the diffusion of a cholesteric-liquid-crystal polymer fixed weakly may be most diffused partially or completely from for example, the source of UV irradiation in the layer to which the film 1 was fixed, or a field. Such diffusion can cause change of a part light reflex band, and is EP 606 940 again. Reflective bandwidth can be expanded so that it may be indicated. Therefore, when the applied physical conditions are still the same between processes, as for such diffusion, an optical property is changed, and an optical property is fixed by UV irradiation after that.
[0052] As for both of these, the example of the cholesteric-liquid-crystal polymer suitable for using it as a film 1 is available from Wacker including the mixture of CC 4039 L and 43% CC 4070 L 57%. The photopolymerization initiator of Ciba-Geigy to available Irgacure 907 etc. is added to this mixture 3% of the weight. For example, the free-surface film for the assemblies within LCD is manufactured using for example, the hot lamination approach or the standard polymer coating process of other arbitration. It is formed between a substrate and a lamination sheet, and rubbing processing of both of substrates and lamination sheets may be carried out before film adhesion, and a film 1 may be assembled in parallel orientation. For example, coating of the orientation layer of a polyamide may be carried out to a substrate and/or a lamination sheet. A lamination sheet can be removed at the suitable process of the arbitration of manufacture.
[0053] Orientation processing of the film 1 is carried out after a coating procedure by heating even in about 30 minutes and between 80 degrees C and 110 degrees C. Avoiding that give a suitable mask, and the field by which current processing is not carried out does not mean, but is exposed at an after that, for example, each exposure, process, a film 1 is processed in order to form red and a green and blue transparency field in order of arbitration.
[0054] In order to form a blue transparency field, a film 1 is slowly cooled to a room temperature, and it carries out time amount neglect that it is only sufficient for a reflective band shifting even to about 625 nanometers. The Gokami front face 2 is irradiated for about 30 seconds in the narrow-band UV which has the bandwidth of about 10 nanometers focusing on 330 nanometers. Thus, by exposing, the up layer of a film 1 is fixed to the depth equivalent to UV absorption depth. This depth is about 1 micron. The furthest cholesteric-liquid-crystal polymer from the source of an exposure located downward can react to a temperature rise by not receiving UV substantially but lowering the helical pitch of a cholesteric ingredient. The polymer located in the middle between the upper front face 2 of a film 1 and the following table side 4 is exposed by UV line a little, and is inferior in the reaction capacity over a temperature change. Consequently, bandwidth can extend the temperature of the cholesteric-liquid-crystal polymer film 1 to a short wavelength side by raising even 80 degrees C for 30 minutes.
[0055] In addition to the escape of the bandwidth caused by the heat discoloration effectiveness, bandwidth is extended to a long wavelength side by diffusion to the fixed up layer of a non-fixing polymer. Consequently, a film 1 comes to reflect red light and green light, and only blue glow is penetrated. This property is eternally fixed in a blue transparency field by exposing on a broadband UV line after that.
[0056] In order to form the field which penetrates the red part of a spectrum, a film 1 is slowly heated to 80 degrees C, and it exposes on UV line for 30 seconds on the wavelength of 330 nanometers after that. The up layer which adjoins a front face 2 is fixed by this, and it comes to reflect the light of the wavelength which is about 450 nanometers. A film 1 is further heated for 30 minutes at 80 degrees C after that, and bandwidth is made to expand to a long wavelength side according to the above-mentioned spreading effect. The property of a filter is eternally fixed by exposing on a broadband UV line after that, and the field in which both green light and blue glow are reflected is formed.
[0057] In order to form a green field, a film 1 is slowly heated to about 105 degrees C, and it exposes for about 25 seconds on UV line with a wavelength of 320 nanometers after that. Thereby, an up layer is fixed and it comes to reflect the light of the wavelength near 400 nanometer. A film 1 is maintained at the temperature of 105 degrees C for 30 more minutes after that, and the reflective

band of an up layer is moved to a long wavelength side by diffusion. The non-fixing polymer located downward reflects blue glow succeedingly. Consequently, only green light is penetrated. 330-nanometer UV line -- for 18 seconds -- exposing -- a polymer -- more -- deep -- until -- it fixes partially. This depth can be finely tuned by continuing heating. A property is eternally fixed by exposing on a broadband UV line after that. Typical UV exposure level is about 0.3 mW/cm2. Exposure wavelength can be determined by inserting the interference filter of bandwidth equal to 10 nanometers of nominal ratings between the source of UV, and a film 1. The exposure time is 20 microns in thickness substantially, and is suitable for the film prepared between two glass substrates. However, the actual exposure time can be adjusted according to the thickness of a substrate, and the difference in an ingredient.

[0058] Drawing 3 a, and 3b and 3c show the optical transparency spectrum of the circular polarization of light which carries out incidence to the red, the green, and the blue field which were formed by the above-mentioned approach. Through and the circular polarization of light were acquired for unpolarized light on the linearly polarized light child and the quarter wavelength film. In fact, almost all wavelength is considered that it can change into a desired circular polarization of light condition using a little component of the opposite revolution direction. The component of the mistaken revolution direction passes a filter and pollutes a transparency spectrum. For example, as for the engine performance of a typical quarter wavelength film, in a blue spectral region, this operation is looked at by the spectrum of drawing 3 a, and 3b and 3c not much well.

[0059] In order to improve the quality of a filter, the output light from the whole filter may pass an absorption circular polarization of light child. The light of the required polarization revolution direction and a required color is changed into the linearly polarized light. The light of the polarization revolution direction which was mistaken or it was not desirable is changed and absorbed by the rectangular polarization condition. By this, as shown in drawing 4 a, and 4b and 4c, saturation improves substantially.

[0060] Drawing 5 shows the engine performance of such a filter in case light carries out incidence at an angle of an on-axis and an off-axis. The coordinate of drawing 5 is shown in accordance with CIE 1931 standard coordinate by the rectangular head [ the target specification of a color filter ] without shade. The trigonum, the rectangular head, and the diamond with shade show the engine performance in case light carries out incidence at the include angle which adjoins each notation. When light carries out incidence in the range whenever [ useful incident angle ] right-angled, the excellent engine performance is attained. If whenever [ incident angle ] becomes large, the engine performance of a filter will fall. The engine performance of an off axis may improve according to the more complicated structure which is explained below and may be formed by the same approach.

[0061] Drawing 6 shows the typical filter containing the levorotation (left-handed) reflective mold cholesteric polymer 1 which was formed by such approach and formed on the substrate 6. the field which penetrates the red, the green, and the blue part of a visible spectrum -- in addition, the field 7 in which all the visible wavelength of the fixed revolution direction emitted by the light source of the right-angle incidence polarization white light 8 is reflected may be formed. Therefore, the "black matrix" or the "black mask" which improves the contrast of a display can be offered, using this filter. For example, the wavelength plate 9 which changes the circular polarization of light into the linearly polarized light can be formed in the output side of a filter. Or a wavelength plate 9 can be formed in the input side of a filter.

[0062] Although drawing 7 -10 are suitably produced by the above-mentioned approach, they show the transparency mold color filter which may be instead formed also by the other approaches. These filters show improvement in the engine performance of an off axis, and although the filter which has a wide range application is offered, thereby, the engine performance of an on-axis may be spoiled a little.

[0063] Drawing 7 shows the red filter which filters the left-hand (left handed) circular polarization of light which carries out incidence. A filter contains the green levorotation layer 10, the blue levorotation layer 11, and the yellow / orange dextrorotation (right handed) layer 12. Layers 10-12 contain in a layer the cholesteric reflector which reflects in a right angle the light of the regular revolution direction which carries out incidence, and the part of a convention of a spectrum, respectively.

[0064] The part on the left-hand side of drawing 7 shows the engine performance to the polarization which carries out incidence to a right angle substantially to the front face 2 of a film 1. The green part G of a visible spectrum is reflected by the layer 10, and the blue part B of a spectrum is reflected by the layer 11. the visible spectrum containing the remaining red part R -- three layers 10, 11, and 12 -- all penetrate.
[0065] The part on the right-hand side of drawing 7 shows the actuation to the light which carries out incidence to an acute angle on a front face 2 to a normal. If it is each part of a visible spectrum at the time of right-angle incidence, it is reflected by the layer which reflects the light of long wave length more. Therefore, the blue part B is reflected by the layer 10. Although the green part G passes layers 10 and 11, the direction of polarization changes by the birefringence of the off axis of these layers. Therefore, when the green part G carries out incidence to a layer 12, the polarization is substantially changed into the left-hand circular polarization of light. The reflective band of a layer 12 is chosen so that the green part G of a spectrum may be substantially reflected with the dextrorotation yellow / orange right-angle reflective engine performance of a layer 12. Red light passes layers 10, 11, and 12 as a request.
[0066] Drawing 8 shows the green transparency mold filter which contains the infrared layer 13, the blue layer 14, the redbed 15, and the green dextrorotation reflecting layer 16 of the levorotation, respectively. The part on the left-hand side of drawing 8 shows the actuation to the left-hand circular polarization of light which carries out incidence to a right angle substantially. Although the amount of [ R, G, and B ] visible region passes the levorotation infrared layer 13 altogether, the blue part B is reflected by the layer 14. Although the red part R is reflected by the layer 15, the green part G penetrates a film 1.
[0067] The part on the right-hand side of drawing 8 shows the actuation to the light which inclines to a normal and carries out incidence to a front face 2. The red part R is reflected by the infrared reflecting layer 13. The rate of a birefringence to the blue part B of layers 13, 14, and 15 is so large that the blue part B is changed into the right-hand (right handed) circular polarization of light from the left-hand circular polarization of light and is reflected by the green dextrorotation layer 16 as a result. The birefringence of the off axis of layers 13 and 14 changes the green levorotation part G into the dextrorotation penetrated by the redbed 15.
[0068] Drawing 9 shows actuation of the blue transparency mold filter to the left-hand circular polarization of light which carries out incidence to a front face 2. A filter contains the cholesteric layers 17, 18, and 19 which reflect the infrared rays, the red, and the green part of a spectrum of the left-hand circular polarization of light, respectively.
[0069] The part on the left-hand side of drawing 9 shows the engine performance to on-axis incident light or right-angle incident light. A layer 18 reflects the red part R, a layer 19 reflects the green part G and the blue part B is penetrated.
[0070] The part on the right-hand side of drawing 9 shows the engine performance to off-axis light. The red part R is reflected by the layer 17 and the green part G is reflected by the layer 18. The total rate of a birefringence to the off axis light of layers 17 and 18 is so large that polarization of the blue part B is changed into the right-hand circular polarization of light from a left hand and the blue part B passes a layer 19.
[0071] The green transparency mold filter shown in drawing 10 differs from the filter which the thin levorotation green reflective cholesteric layer 20 shows to drawing 9 with the point that light is adjoined and prepared in the front face or the input front face 2 which carries out incidence. Since a layer 20 reflects the green part G of an on-axis partly, and some are reflected even if there are few blue parts B of an off axis, the green dextrorotation layer 16 may be omitted. This arrangement makes the engine performance of an on-axis a sacrifice a little, and raises the engine performance of an off axis, and the low green transparency mold filter of a dependency to whenever [ over a front face 2 / incident angle ], and the outgoing radiation include angle from a front face 4 is offered.
[0072] A suitable amendment layer may be prepared as the last layer which adjoins the front face 4 of the films 1 of all the filters shown in drawing 7 -10. Such an amendment layer may be arranged in order to change all transparency components into the same polarization condition, or in order to make a polarization condition in agreement with LCD.
[0073] In order to offer the color transparency mold filter suitable for filtering the unpolarized light

white light 21, as shown in drawing 11 , the laminating of the cholesteric film according to individual may be carried out. In this case, a substrate 6 has cholesteric polymer film 1a which filters a left-hand circular polarization of light component, and has cholesteric polymer film 1b which filters the right-hand circular polarization of light penetrated by this degree by film 1a.

[0074] Drawing 12 shows the alternative arrangement for filtering the unpolarized light white light 21. In this case, a substrate 6 has the cholesteric polymer film 1 which filters the left-hand circular polarization of light, and this film 1 is separated with the broadband half-wave length film 22 which changes the circular polarization of light of a certain revolution direction in the opposite revolution direction. Even a film 22 penetrates the right-hand circular polarization of light, it is a film 22 and, as for the cholesteric polymer film 1 contiguous to a substrate 6, polarization is reversed by the left-hand circular polarization of light. Therefore, a film 1 penetrates the red, the green, and the blue part of a spectrum so that both sides may act and illustrate to the left-hand circular polarization of light.

[0075] The above-mentioned approach can be used in order to form a wavelength plate for example, in a cholesteric film. For example, it is possible to incorporate the wavelength plate which changes the circular polarization of light into the linearly polarized light on the output front face 4 of a film 1. Such a wavelength plate can be combined with a color filter. Drawing 13 shows the engine performance when combining a green color filter and a wavelength plate. A wavelength plate can be formed by making an about six-substrate cholesteric-liquid-crystal polymer incline using a surface effect or electric field. A polymer is fixed using UV line after that.

[0076] The transparency shown in drawing 13 is standardized on the basis of a single linearly polarized light child. A linearly polarized light green filter is illuminated by unpolarized light. If it sees through the output polarizer arranged at the rectangular cross, a filter will function as a green transparency mold filter, as a curve 23 shows. When it sees through the linearly polarized light child stationed in parallel, a filter appears like a neutral transparency object.

[0077] a-14d of drawing 14 shows the transparency spectrum of the green transparency mold filter formed using gray dead pitch distribution when a model is made using the 4x4 transformation-matrix theory. Simulation was performed about a different angle of incidence, using a short pitch front face as an input front face. About the filter of the levorotation, a continuous line shows the engine performance to left-hand circular polarization of light incident light, and the curve of a broken line shows the engine performance to right-hand circular polarization of light input light.

[0078] The transparency band of a filter moves to a low wavelength side as an incident angle becomes large.

[0079] Drawing 15 shows the emission spectrum of typical fluorescence tubing used with LCD. In the green part of a spectrum, a back light has a comparatively narrow luminescence peak.

[0080] Consequently, when it sees by the on-axis, or when it sees by the comparatively small incident angle, the green filter which shows that engine performance to a-14d of drawing 14 has about 60% of the maximum permeability. When it sees by the off-axis using the light source of the type which has the engine performance shown in drawing 15 , transparency changes with include angles.

[0081] In order to conquer such un-arranging, the green filter which uses the above-mentioned approach and has the block or layer of some of different pitches fully separated can be offered, and the filter which has the transparency spectrum shown in a-16d of drawing 16 can be formed. Optical effectiveness improves substantially and the dependency over an angle of visibility is reduced substantially.

[0082] Each class has the thickness of 15 pitches including eight cholesteric layers in which the cholesteric film in which the engine performance is shown has 253, 272, 291, 310,320,383,400, and the pitch of 420 nanometers in a-16d of drawing 16. Cholesteric refractive indexes are 1.53 and 1.63, and the substrate and up substrate of 1.52 are adopted for a refractive index.

[0083]

[Effect of the Invention] As mentioned above, according to the invention in this application, the approach of making it possible to form the three-dimensional structure in a polymer film as a single component or equipment can be offered. For example, this approach may be used in order to form various filters. Profitableness is inferior although such a filter may be formed by other techniques. The structure of a film is a cholesteric part optical filter or other equipments, and in order to attain a

desired include-angle response characteristic, it may be changed with the depth. The complicated three-dimensional structure can be formed according to the capacity which controls the property of the anisotropy of a liquid crystal molecule, and the orientation of these molecules by impression of a surface effect, electric field, or a field, and the capacity which fixes the orientation of UV light. For example, a single film notch filter and a single film RGB transparency mold color filter may be formed.

[0084] The angular dependence of equipments, such as a filter, may be controlled using these techniques. For example, the part optical filter which holds the engine performance on the incident angle and outgoing radiation angle of the range larger than the case of well-known equipment can be offered.

[0085] I hear that another advantage of such a cholesteric color filter may be used by the system which has the big flux of lights, such as a projector system, and there is. Since it is rather reflected rather than an unnecessary light is absorbed especially, the thermal stress concerning a filter becomes low. Therefore, improvement in the stability of a color and a life of operation may be attained.

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[Translation done.]

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]
[Drawing 1 a] It is the outline sectional view showing the 1st process of the approach by 1 operation gestalt of this invention.
[Drawing 1 b] It is the outline sectional view showing the 2nd process of the approach by 1 operation gestalt of this invention.
[Drawing 1 c] It is the outline sectional view showing the 3rd process of the approach by 1 operation gestalt of this invention.
[Drawing 2] It is the graph of the wavelength (nano metric unit) to a Celsius degree which shows the temperature dependence of the wavelength of a single cholesteric-liquid-crystal polymer cel.
[Drawing 3 a] It is the graph which expressed with permeability the transparency spectrum to the wavelength (nano metric unit) of the red color filter illuminated by the circular polarization of light.
[Drawing 3 b] It is the graph which expressed with permeability the transparency spectrum to the wavelength (nano metric unit) of the green color filter illuminated by the circular polarization of light.
[Drawing 3 c] It is the graph which expressed with permeability the transparency spectrum to the wavelength (nano metric unit) of the blue color filter illuminated by the circular polarization of light.

[Drawing 4 a] Although it is similar to drawing 3 a, it is the graph which can be attained by using an output circular polarization of light child and which showed improvement in the engine performance.

[Drawing 4 b] Although it is similar to drawing 3 b, it is the graph which can be attained by using an output circular polarization of light child and which showed improvement in the engine performance.

[Drawing 4 c] Although it is similar to drawing 3 c, it is the graph which can be attained by using an output circular polarization of light child and which showed improvement in the engine performance.

[Drawing 5] It is drawing showing angle change of the CIE color coordinate of a narrow angle color filter.
[Drawing 6] It is drawing by 1 operation gestalt of this invention which has a black matrix and in which showing the color filter by which picture element division was carried out.
[Drawing 7] It is the outline sectional view showing the engine performance of the red filter by 1 operation gestalt of this invention, an on-axis, and an off axis.
[Drawing 8] It is the outline sectional view showing the engine performance of the green filter by 1 operation gestalt of this invention, an on-axis, and an off axis.
[Drawing 9] It is the outline sectional view showing the engine performance of the blue filter by 1 operation gestalt of this invention, an on-axis, and an off axis.
[Drawing 10] It is the outline sectional view showing the alteration of the green filter shown by drawing 8 .
[Drawing 11] It is the outline sectional view showing the laminating filter used with unpolarized light.
[Drawing 12] It is the outline sectional view which is used with unpolarized light and in which showing the same filter separated by the broadband half-wave plate.

[Drawing 13] It is the graph which showed the transparency to the wavelength (nano metric unit) of a linearly polarized light green filter by 1 operation gestalt of this invention with permeability.
[Drawing 14 a] It is the graph of the transparency to the wavelength (nano metric unit) of the levorotation green GUREDEDDO pitch cholesteric filter illuminated on the short pitch surface, and the curve of a broken line expresses the reaction of as opposed to the right-hand circular polarization of light for the reaction to the left-hand circular polarization of light at the time of zero angle of incidence in the curve of a continuous line.
[Drawing 14 b] It is the graph of the transparency to the wavelength (nano metric unit) of the levorotation green GUREDEDDO pitch cholesteric filter illuminated on the short pitch surface, and the curve of a broken line expresses the reaction of as opposed to the right-hand circular polarization of light for the reaction to the left-hand circular polarization of light at the time of ten angles of incidence in the curve of a continuous line.
[Drawing 14 c] It is the graph of the transparency to the wavelength (nano metric unit) of the levorotation green GUREDEDDO pitch cholesteric filter illuminated on the short pitch surface, and the curve of a broken line expresses the reaction of as opposed to the right-hand circular polarization of light for the reaction to the left-hand circular polarization of light at the time of 20 angles of incidence in the curve of a continuous line.
[Drawing 14 d] It is the graph of the transparency to the wavelength (nano metric unit) of the levorotation green GUREDEDDO pitch cholesteric filter illuminated on the short pitch surface, and the curve of a broken line expresses the reaction of as opposed to the right-hand circular polarization of light for the reaction to the left-hand circular polarization of light at the time of 30 angles of incidence in the curve of a continuous line.
[Drawing 15] It is the graph of the reinforcement to the wavelength of an Angstrom unit which shows the spectrum of the typical back light for LCD.
[Drawing 16 a] It is a graph containing two or more separate layers similar to drawing 14 a about a levorotation green cholesteric filter.
[Drawing 16 b] It is a graph containing two or more separate layers similar to drawing 14 b about a levorotation green cholesteric filter.
[Drawing 16 c] It is a graph containing two or more separate layers similar to drawing 14 c about a levorotation green cholesteric filter.
[Drawing 16 d] It is a graph containing two or more separate layers similar to drawing 14 d about a levorotation green cholesteric filter.
[Description of Notations]
1 Film
2 Upper Front Face
3 Field Fixed by UV
4 Following Table Side
30 Temperature Controller
6 Substrate
7 Field in which All Visible Wavelength of the Fixed Revolution Direction Emitted by Light Source of Right-Angle Incidence Polarization White Light 8 is Reflected
8 Right-Angle Incidence Polarization White Light
9 Wavelength Plate
10 Green Levorotation Layer
11 Blue Levorotation Layer
12 Yellow / Orange Dextrorotation Layer
13 Levorotation Infrared Layer
14 Levorotation Blue Layer
15 Levorotation Redbed
16 Dextrorotation Green Reflecting Layer
17 Levorotation Infrared Cholesteric Layer
18 Levorotation Red Cholesteric Layer
19 Levorotation Green Cholesteric Layer
20 Thin Levorotation Green Reflective Cholesteric Layer

21 Unpolarized Light White Light
22 Broadband Half-wave Length Film
1a Levorotation reflective mold cholesteric polymer
1b Dextrorotation reflective mold cholesteric polymer

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[Translation done.]

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## DRAWINGS

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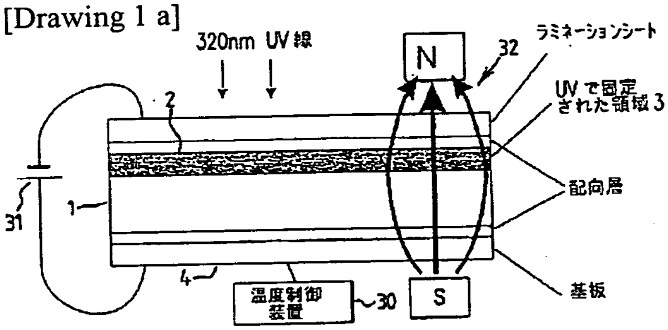
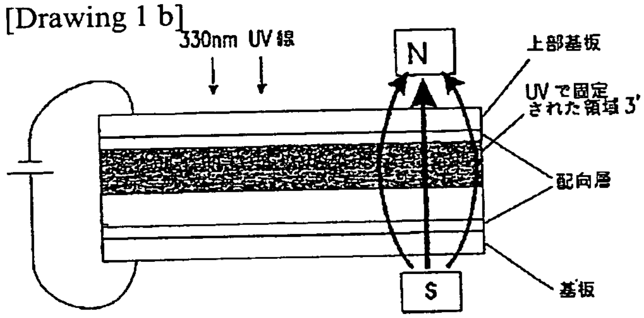
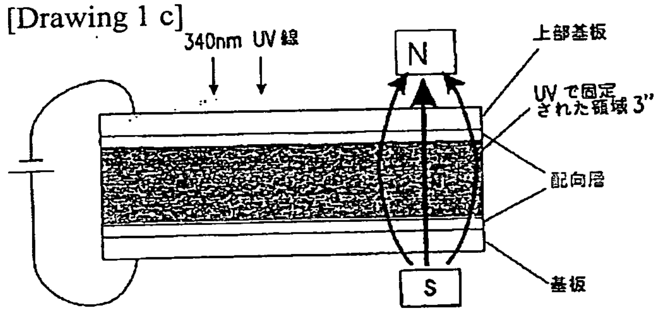
[Drawing 1 a]



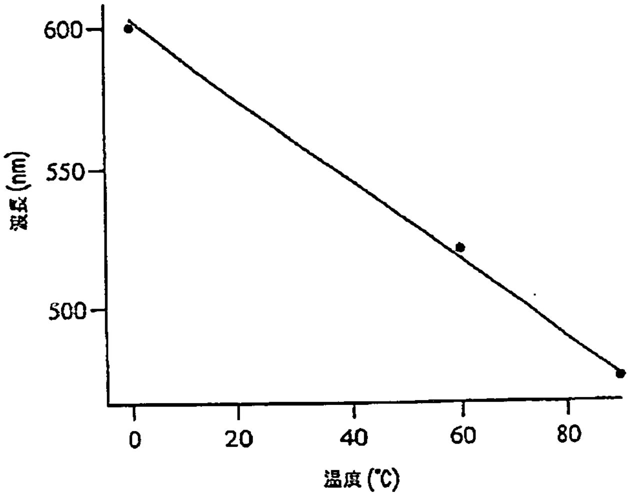

[Drawing 1 b]



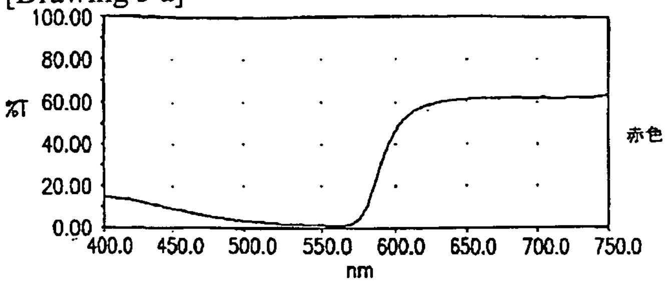

[Drawing 1 c]



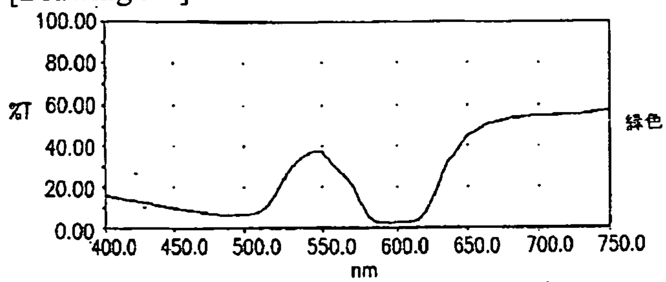

[Drawing 2]



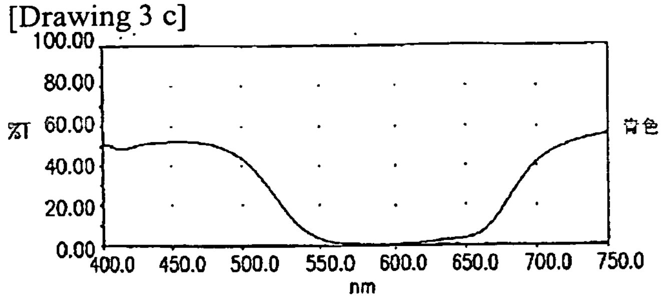

[Drawing 3 a]



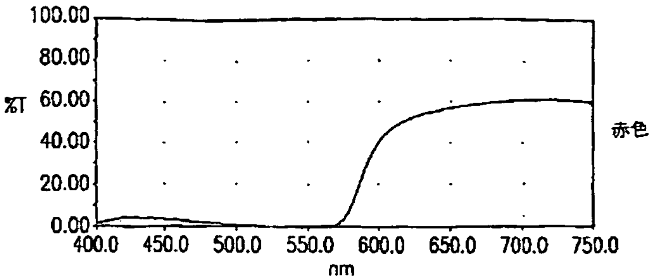

[Drawing 3 b]



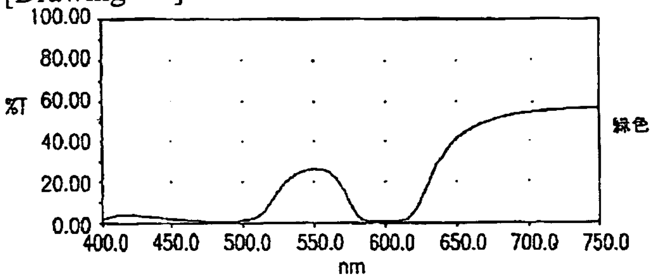

[Drawing 3 c]



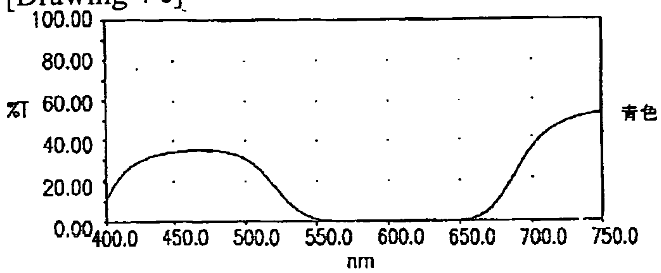

[Drawing 4 a]



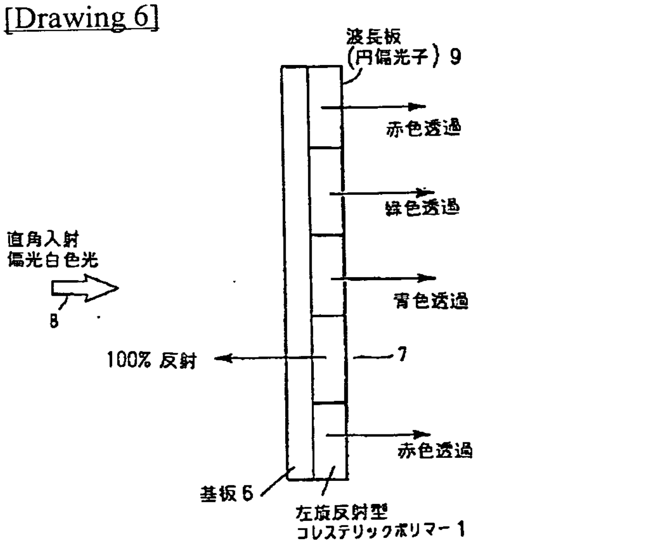

[Drawing 4 b]



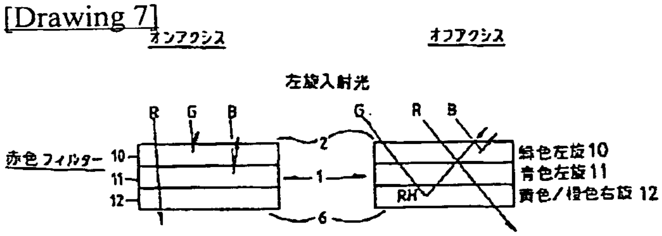

[Drawing 4 c]



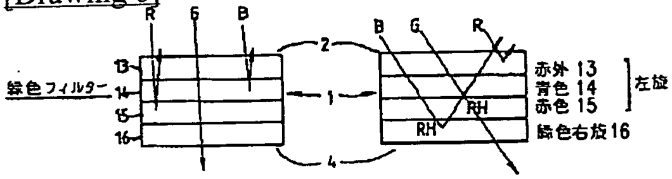

[Drawing 6]



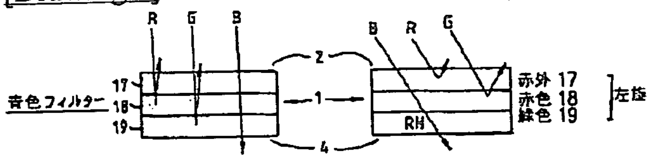

[Drawing 7]



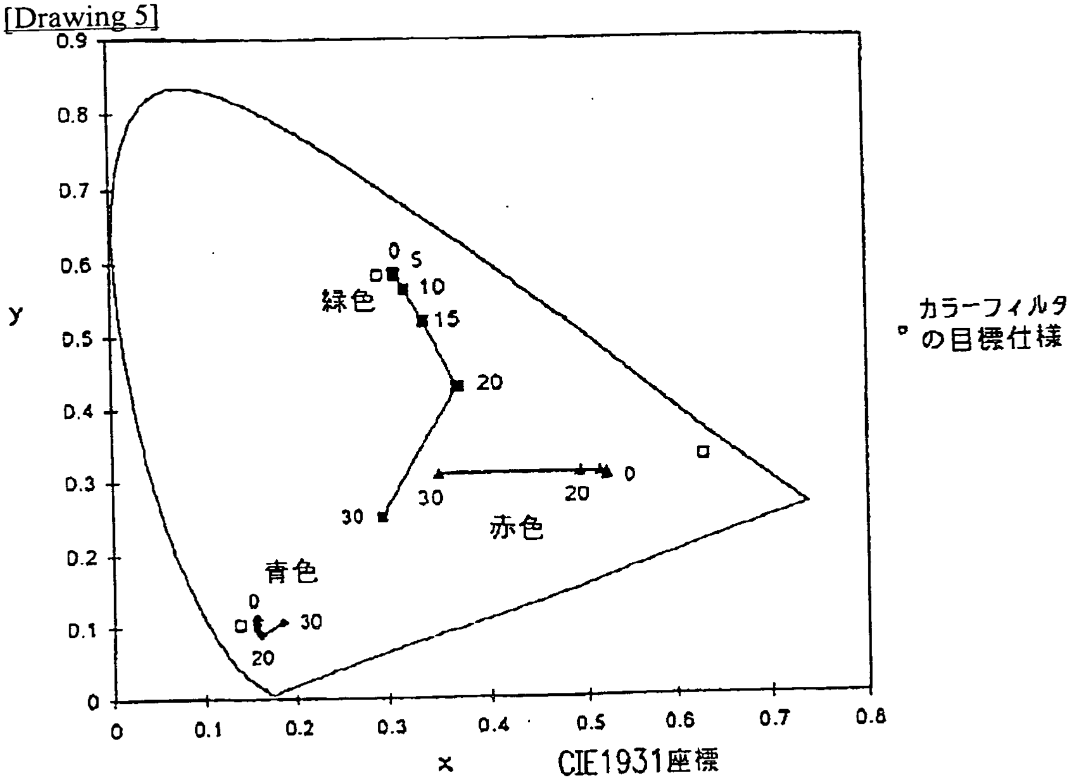
[Drawing 8]



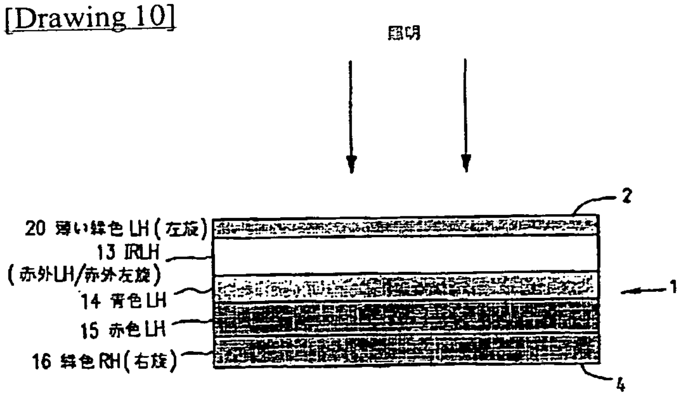

[Drawing 9]



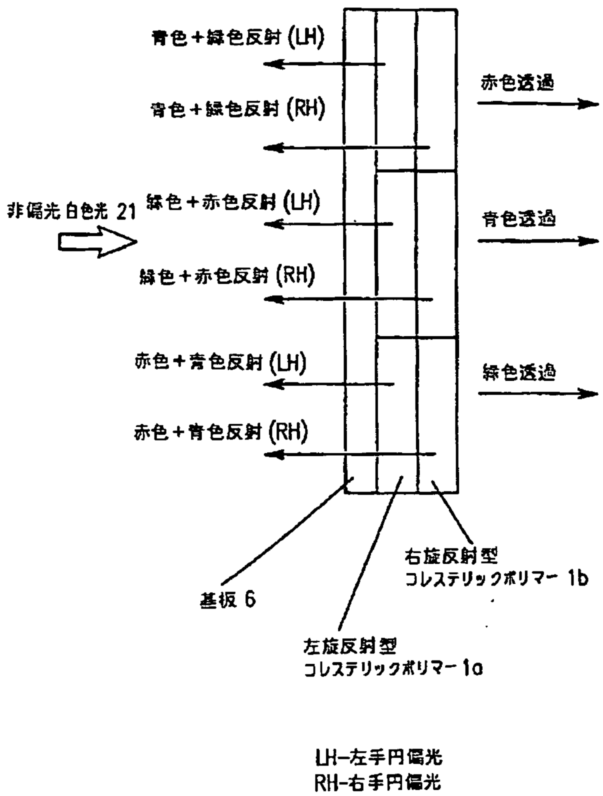

[Drawing 5]



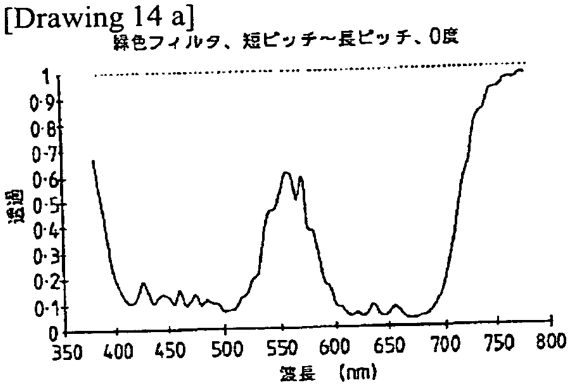

[Drawing 10]



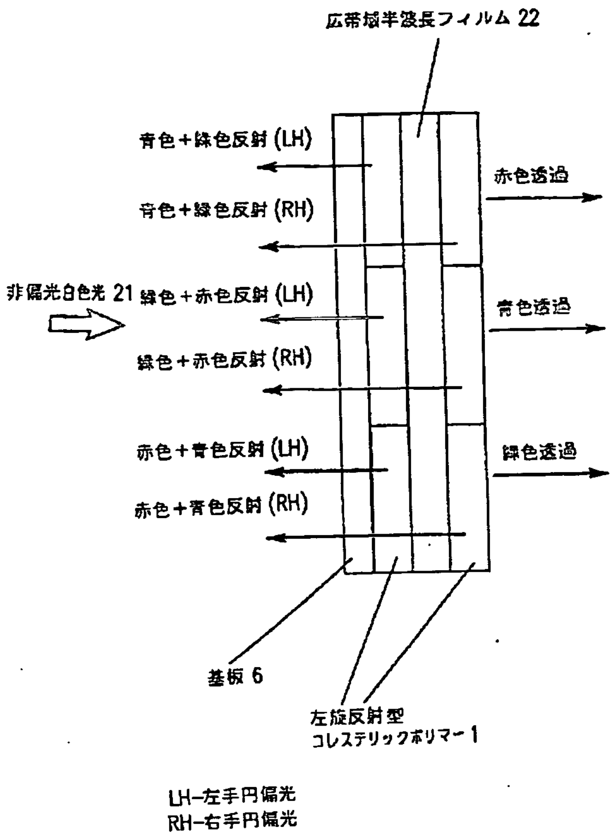

[Drawing 11]



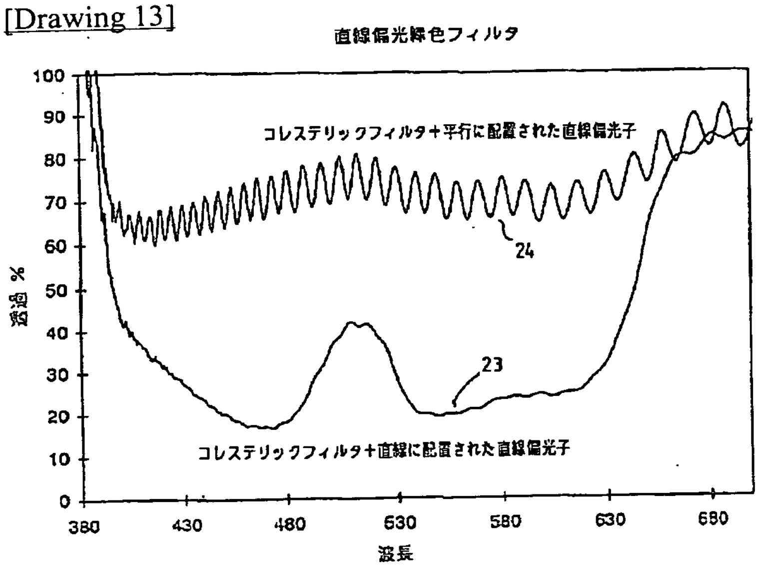

[Drawing 14 a]



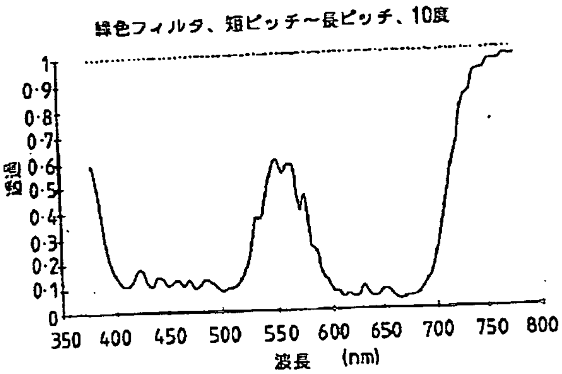

[Drawing 12]



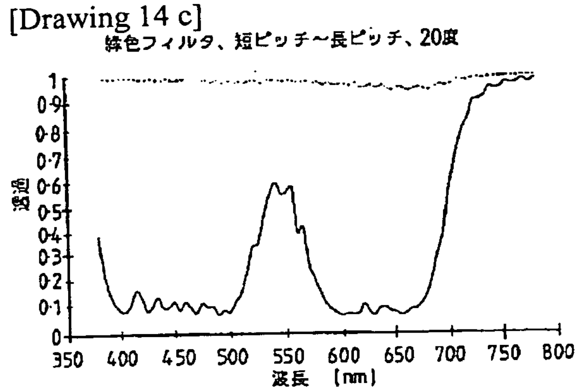

[Drawing 13]



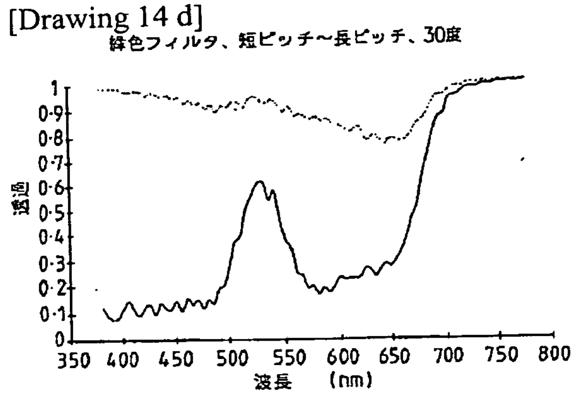

[Drawing 14 b]



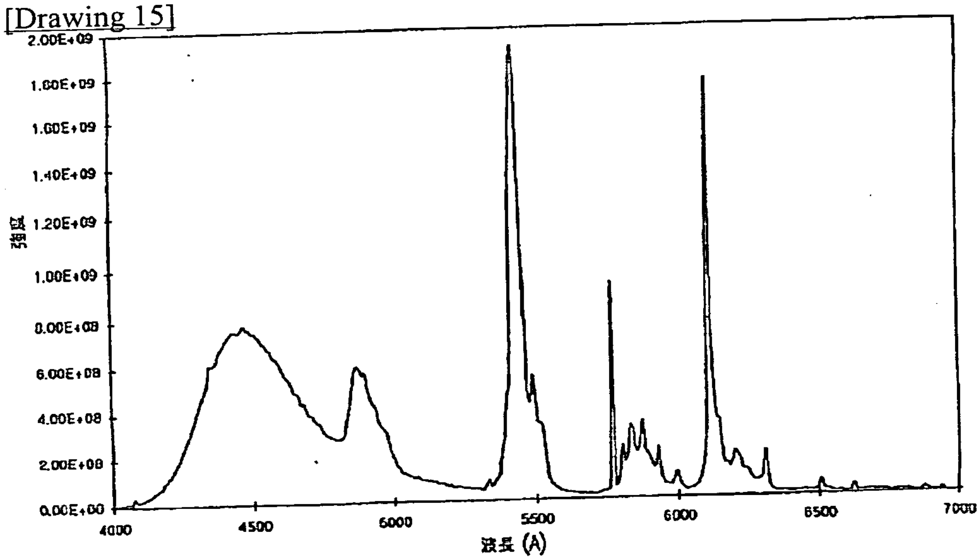

[Drawing 14 c]



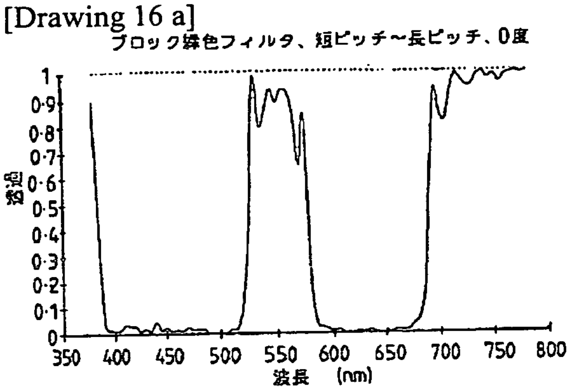

[Drawing 14 d]



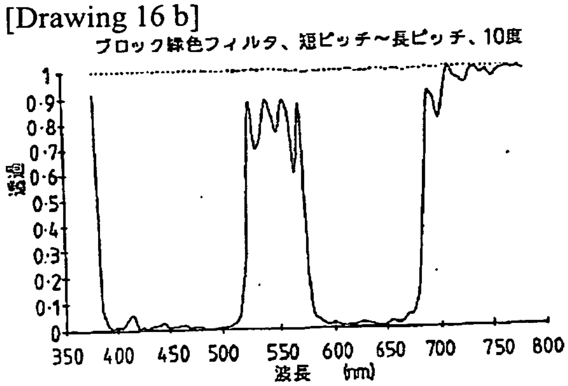

[Drawing 15]



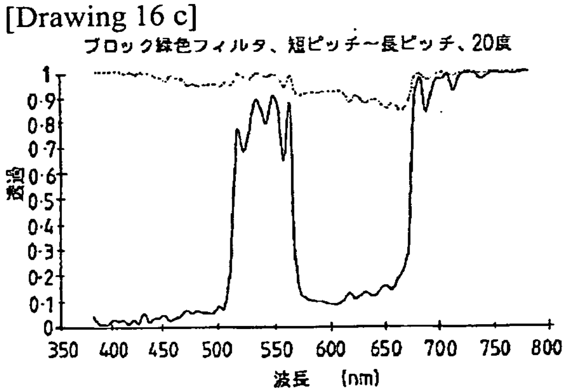
[Drawing 16 a]



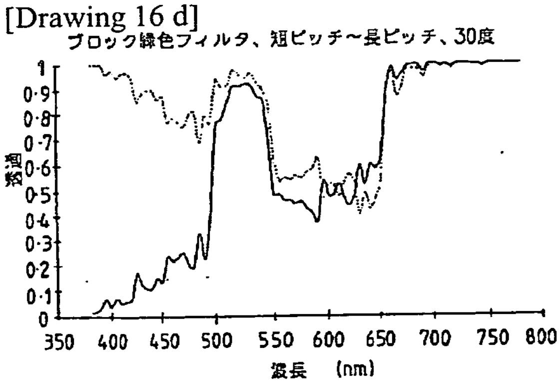

[Drawing 16 b]




[Drawing 16 c]




[Drawing 16 d]

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[Translation done.]